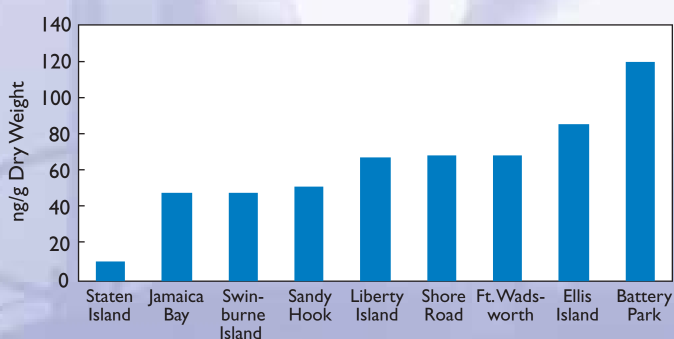
Changes in Organic Contamination in Mussels in New York Harbor after September 11, 2001

The September 11, 2001, attack on the World Trade Center (WTC) resulted in a massive plume of dust and smoke that blanketed lower Manhattan Island and the adjacent harbor area. The NOAA has been monitoring five Mussel Watch Project sites in the Hudson-Raritan Estuary since 1986 for a series of organic chemicals, including PAHs, DDT and other chlorinated pesticides, and PCBs (additional information is available at http://nsandt.noaa.gov). In 1995, those analyses were augmented with measurements of dioxins, furans, and coplanar PCBs, and in 1999, polybrominated biphenyls (PBBs), commonly found in flame retardants, were also quantified. In December 2001, mussels were collected at the five Mussel Watch sites, as well as at four additional sites. Despite the attack on the WTC, the general pattern of improving environmental conditions, continued and was documented by NOAA's Mussel Watch Project. This conclusion holds for PAHs, DDT, chlordane, dieldrin, PCBs, furans, and PBBs. The chemical exceptions are dioxins and polybrominated diphenyl ethers (PBDEs).



Concentrations (ng/g dry weight) of PDBEs following geographic gradient, increasing from Staten Island towards the Battery Park site closest to the WTC (developed by NOAA for the National Coastal Condition Report II).

Dioxin concentrations in December 2001 were generally higher than in 1995. Of the sites sampled, Sandy Hook, Ellis Island, Staten Island, and Shore Road all had higher dioxin mussel tissue concentrations than the highest concentration reported for 1995. The highest concentration of 913 pg/g was found at Shore Road, one of the December 2001 special collection sites and the site located furthest from the WTC.

PBDEs are widely used as flame retardants in items such as furniture and are some of the most likely contaminants to have been mobilized by the WTC disaster. PBDEs have not previously been measured by the Mussel Watch Project; therefore, there are no data to compare across time. PBDE concentrations range from the vicinity from a low of 9.4 ng/g at Staten Island to a high of 119 ng/g at Battery Park. Mussel tissue concentrations of PBDEs generally follow a geographical pattern, with sites with the lowest concentrations typically being located south of the Verrazano Narrows Bridge. With the exception of the Liberty Island site, the general south to north increase in mussel tissue concentrations of PBDEs continues up to the WTC site, with the highest concentrations detected at Battery Park, which lies adjacent to the WTC site.

Sediment Toxicity

Sediment toxicity in Northeast Coast estuaries is rated poor. About 8% of estuarine sediments in the Northeast Coast were toxic and considered in poor condition (Figure 3-12). Regions highlighted as impaired by this indicator include parts of Cape Cod Bay, western Long Island Sound, New York Harbor, and tidal-fresh parts of tributaries in lower New Jersey and Delaware. Figures 3-12 and 3-13 and statistical analysis reveal a generally weak relationship between sediment contamination (ERM exceedances) and amphipod survival. In part, this may reflect the strict criterion of mortality used to characterize toxicity in the amphipod assay. It also highlights the need for a more complete analysis of the bioavailability of the toxicants, e.g., an analysis that considers the effect of equilibrium partitioning and the mitigating effects of sequestering toxicants with sulfides or organic carbon (DiToro et al., 1991; U.S. EPA, 1993; Daskalakis and O'Conner, 1994).

Sediment Contaminants

The sediment contaminants rating for the Northeast Coast is fair. Eight percent of estuarine area has metal or organic contaminant concentrations that exceed ERM limits, and 12% has concentrations that exceed metal or organic contaminants for five or more ERL limits, but do not exceed ERM limits (Figure 3-13). Poor condition is evident in clusters neighboring major urban areas, including New York Harbor, western Long Island Sound, the upper Chesapeake Bay, and Narragansett Bay. Metals were responsible for most ERM exceedances (primarily nickel and mercury, but also silver and zinc). Most of the remaining ERM exceedances resulted from PCBs and DDT. The 12% of estuarine sediments exceeding ERLs (but not ERMs) for five or more contaminants occurred more frequently for metals (arsenic, chromium, mercury, and nickel) than for organics (primarily DDT).

Sediment Contaminant Criteria (Long et al., 1995)

ERM (Effects Range Median)—Determined for each chemical as the 50th percentile (median) in a database of ascending concentrations associated with adverse biological effects.

ERL (Effects Range Low)—Determined values for each chemical as the 10th percentile in a database of ascending concentrations associated with adverse biological effects.

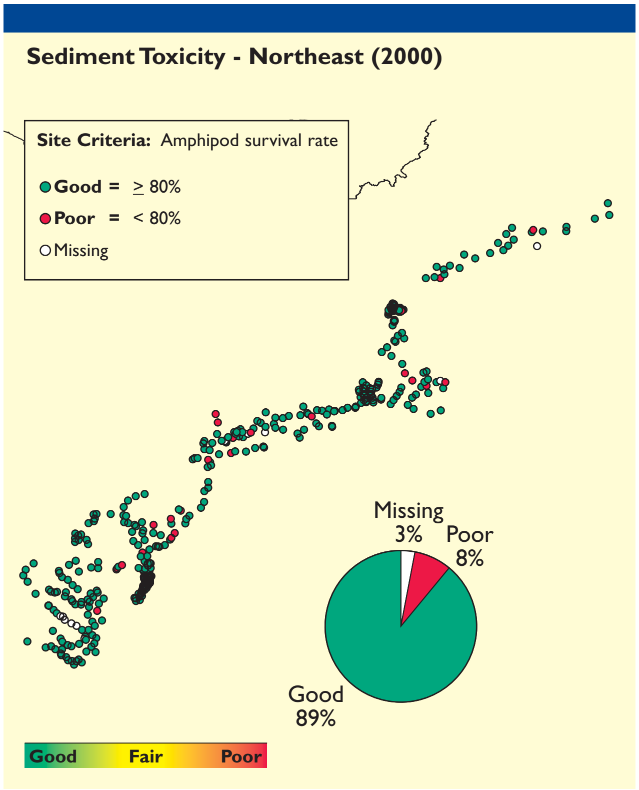


Figure 3-12. Sediment toxicity data for Northeast Coast estuaries (U.S. EPA/NCA).

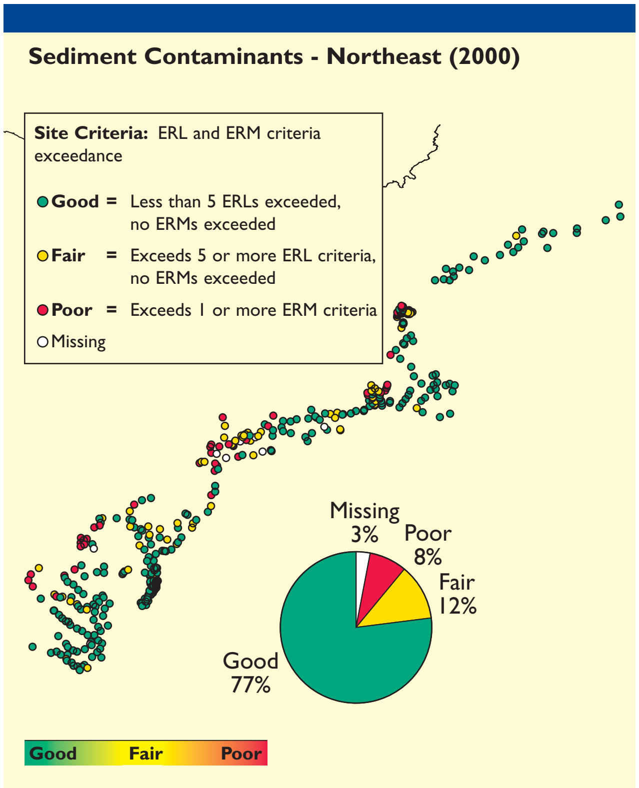
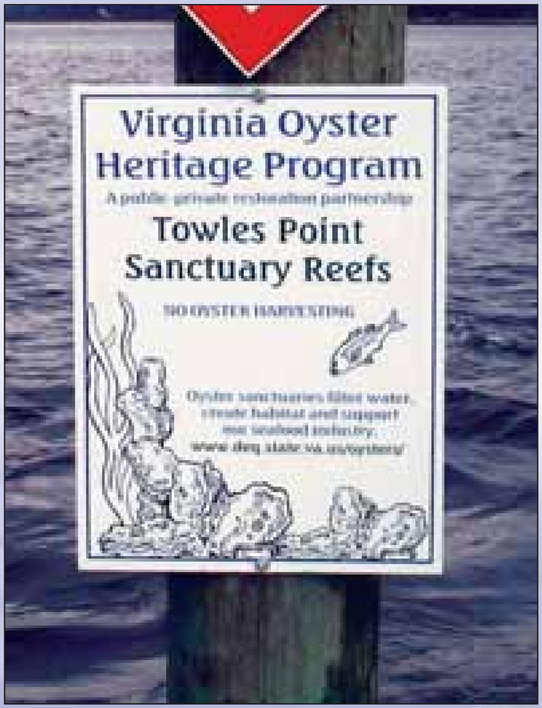


Figure 3-13. Sediment contaminants data for Northeast Coast estuaries (U.S. EPA/NCA).

Virginia Revives its Coastal Heritage and Waters through Oysters

In the early 1900s, oyster landings in Virginia exceeded 9 million bushels annually. Today, the total catch of the state's keystone species is less than 1 percent of that number, and the habitat, water quality, and economic benefits of once-thriving oyster populations have been nearly lost. A collaborative effort spearheaded by the Virginia Coastal Program (VCP) has resulted in a large-scale oyster restoration program, with preliminary monitoring results indicating restoration efforts may be the start of a slow recovery process.

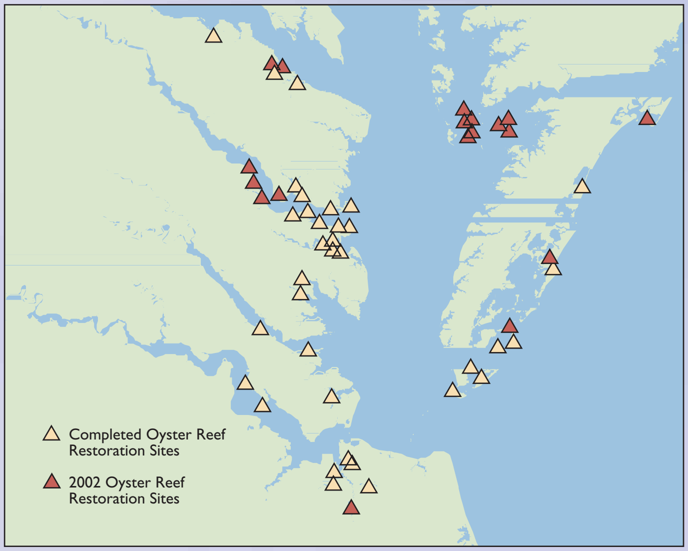


(Photo: Virginia Marine Resources Commission, April 2003)

Since the early 1990s, a number of scientific and environmental agencies have undertaken small-scale oyster restoration projects in Virginia's waters. In 1993, the Virginia Marine Resources Commission (VMRC) began building three-dimensional reefs stocked with disease-tolerant oysters. When that succeeded, the VCP determined it would be worthwhile to increase the project's scale into one large, focused effort.

In March 1999, the VCP established the Virginia Oyster Heritage (VOH) Program, a partnership among state and federal agencies, nonprofit organizations, private companies, and local watermen. The program has managed more than $11 million in funds from federal, state, and private sources. With assistance from watermen, local governments, volunteers, and the U.S. Army Corps of Engineers (USACE), the VMRC is building 1-acre sanctuary reefs throughout Virginia's coastal waters. These designated sanctuaries, consisting of a series of mounds of oyster shell 8 to 10 feet high, provide the substrate necessary for oyster settlement and growth. Planted near them are multi-acre flat beds of shells, where harvest will be allowed. Additionally, volunteer oyster gardeners are planting and growing seed oysters on some of the reefs in conjunction with the Chesapeake Bay Foundation.

During 2000 through 2002, 13 sanctuary reefs were constructed in the lower and upper Rappahannock River, and almost 500 acres of enhanced harvest area were restored with the addition of live oysters and cultch. A large-scale reef restoration effort surrounding Tangier and funded by the USACE began in 2001, with four new reefs and 200 acres of enhanced harvest area. On the seaside of Virginia's Eastern Shore, more than 20 acres of reef also were restored, and by the end of 2002, 8 reefs had been constructed in Tangier and Pocomoke Sounds.



Status of oyster reef restoration in Virginia's coastal zone (Graphic prepared by the Virginia Marine Resources Commission for NCCR II).

In addition to these restoration activities, educating the public about the role oysters play in water quality, biodiversity, and the coastal economy has also been a priority. Thousands of Virginians have learned about the critical role oysters play in keeping coastal waters clean and providing habitat for other marine life. The private, non-profit Virginia Oyster Reef Heritage Foundation has raised hundreds of thousands of dollars and gives businesses and individuals an opportunity to get involved in this initiative. A model for other restoration efforts in the Chesapeake Bay, the VOH Program and its partners served as a catalyst for a bay-wide commitment to increase oyster populations 10-fold over the next 10 years and helped galvanize a bay-wide strategy to meet this commitment. The VOH Program has set the stage with an outdoor laboratory for comprehensive on-the-ground monitoring. Virginia's coastal resource managers have already documented, in numerous places, 10-fold increases in spat abundance where substrate has been provided.

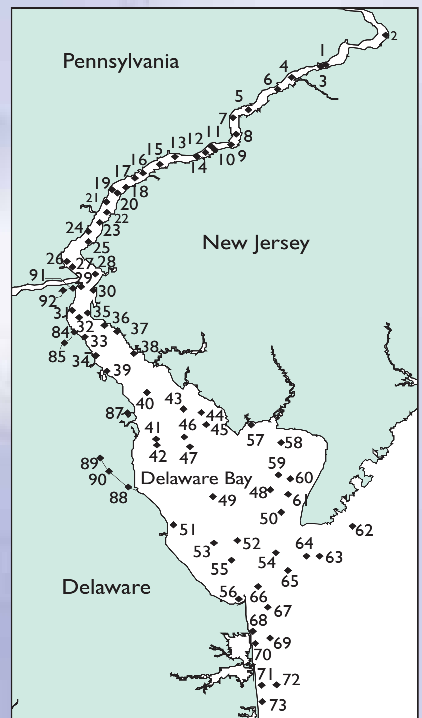
Although scientists are still trying to quantify the reefs' achievements, the partners in the VOH Program are confident about the program's success. Optimism is high that the VOH Program is helping to create an educated citizenry and a sustainable fishery that will benefit both the state's economy and coastal ecosystems.

For more information on the VOH Program, contact Laura McKay at (804) 698-4323 or lbmckay@deq.state.va.us, or Jim Wesson at (757) 247-2121 or jwesson@mrc.state.va.us. Visit the VOH Program at http://www.deq.state.va.us/oysters/ for a map of reef-restoration sites and highlights of monitoring, education, and volunteering activities.

Sediment Toxicity in Delaware Bay

Sediment contamination in coastal waters is an important environmental issue because of its potentially toxic effects on ecological resources, and indirectly, on human health. For this reason, characterizing areas of sediment contamination and toxicity are important goals for coastal resource management.

Delaware Bay, whose watershed drains portions of New York, Pennsylvania, New Jersey, and Delaware, is one of the largest coastal plain estuaries (907 square miles) on the East Coast. The urban centers of Philadelphia, Trenton, Camden, and Wilmington contain numerous sources of contaminants, including municipal and industrial discharges that contribute metals, PCBs, and chlorinated pesticides to the Delaware Bay.



Source: Hartwell et al., 2001

As part of NOAA's NS&T Program, the sediment toxicity of Delaware Bay was measured at 73 stations using a stratified-random sampling design. Samples were concurrently examined for chemical contaminants and BMC structure. Three different toxicity tests were performed: (1) amphipod bioassay survival during 10-day exposures to whole sediment, (2) sea urchin fertilization success in pore waters, and (3) bacterial bioluminescence (Microtox™) in organic extracts of sediment.

Estimates of the area of toxicity in Delaware Bay varied with the bioassay testing procedure used, from 1% toxicity based on the amphipod test to 56% toxicity based on the Microtox™ test, with the sea urchin test resulting in a toxicity estimate of 11%. The latter two tests involve more sediment handling than the amphipod test, and therefore, create less realistic exposures of organisms to sediment. The results of these three tests do not necessarily mean that organisms exposed under natural conditions will be adversely affected. Nonetheless, the 1% of the bay area samples found to be toxic in the amphipod test were also the most heavily contaminated with heavy metals and PAHs.

The condition of BMCs is a response to actual field conditions rather than manipulated laboratory exposures, but is affected by sediment characteristics beyond just chemical contamination. In Delaware Bay, indices of BMC health (e.g., taxa, density, diversity, evenness) were highly variable and poorly correlated with bioassay results. The indices were found to vary much more in response to salinity and to sediment grain size than to any other factors. The upper freshwater portion of the Delaware Bay, however, where chemical contamination was high, was an area where BMCs seem to have been affected most by contamination. For more information, visit http://nsandt.noaa.gov/index_bioeffect.htm.

Sediment Total Organic Carbon

Regions of high TOC content are likely to be depositional sites for fine sediments. If there are pollution sources nearby, these depositional sites are likely to be hot spots for contaminated sediments. Figure 3-14 shows that only 2% of the area of Northeast Coast estuarine sediments have a high TOC content (greater than 5% TOC), and an additional 26% of the area has moderate quantities (2% to 5% TOC). This results in an overall rating of good for TOC in the Northeast Coast. Generally, elevated TOC contents were found in the same locations as contaminated sediments.

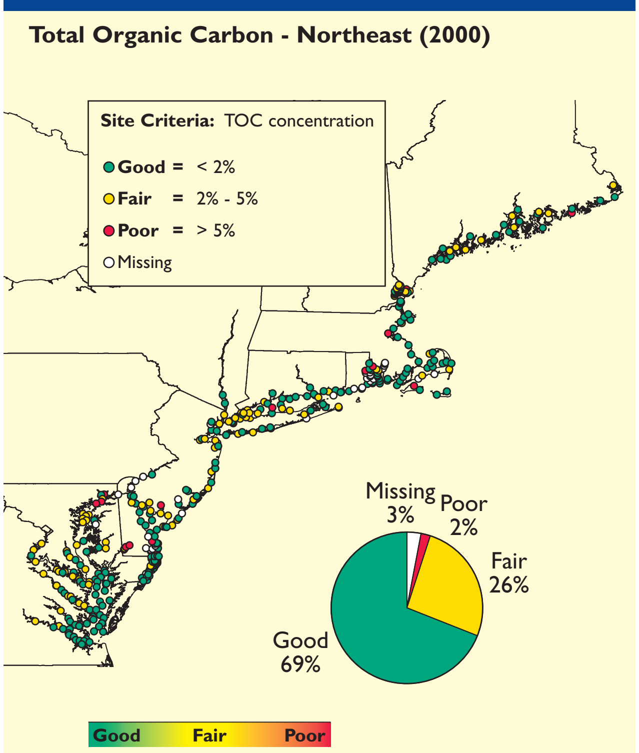


Figure 3-14. Sediment TOC data for Northeast Coast estuaries (U.S. EPA/NCA).

Benthic Index

Coastal condition in the Northeast Coast region as measured by a combination of benthic indices of the Virginian Province (Paul et al., 2001) and the Acadian Province based on biodiversity (developed by NCA for this report) is poor (Figure 3-15). Twenty-two percent of estuarine sediments evaluated using variations in benthic communities in the Northeast Coast received a rating of poor.

Poor conditions are evident at the head of Chesapeake Bay and in most of its major western tributaries. In contrast, most of the eastern shore is in good condition. Poor conditions are also prevalent in many of the Maryland coastal bays, portions of Delaware Bay, New York/New Jersey Harbor, western Long Island Sound, and upper Narragansett Bay. Conditions are good along the northern section of the Maine coast, with localized areas of poor conditions occurring in Maine waters from Penobscot Bay southward.

Coastal conditions in the Acadian Province are more oceanic and have higher bottom-water salinity than in the Virginian Province. In these northern estuaries,

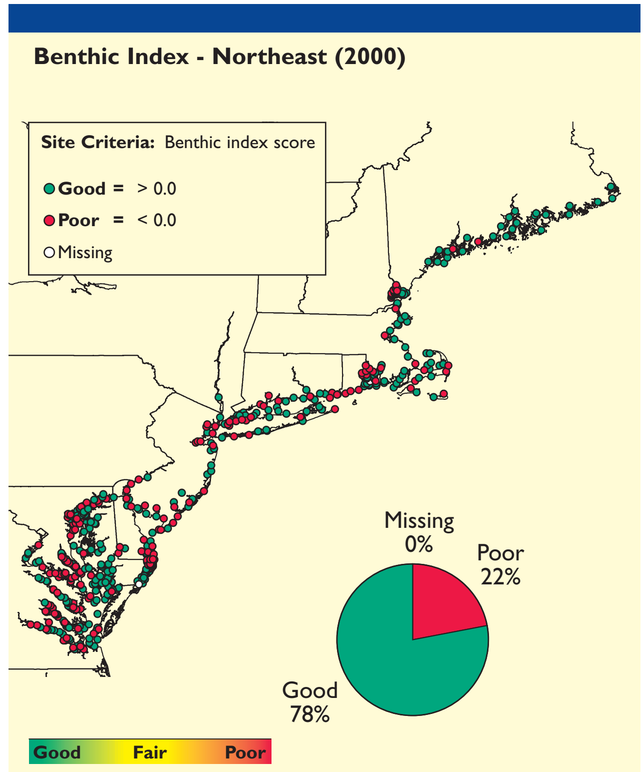


Figure 3-15. Benthic index data for Northeast Coast estuaries (U.S. EPA/NCA).

Northeast Benthic Index

The Northeast Coast region contains two major biogeographic provinces: the Virginian Province, which includes coastal waters along the east coast of Cape Cod and south through Chesapeake Bay, and the EMAP Acadian Province, which includes the U.S coastal waters in the Gulf of Maine. A benthic index (Paul et al., 2001) was used in the Virginian Province based on EMAP Virginian Province data from 1990 to 1993. The EMAP Virginian Province used a level of taxonomic detail for characterizing the benthic community composition comparable to that currently used by the Chesapeake Bay Program and Maryland Coastal Bays Program. However, from Delaware northward through Maine, the analysis of benthic communities used a lower level of taxonomic detail. For the Northeast Coast analysis of benthic conditions summarized in this chapter, the taxonomic detail included in the Chesapeake Bay and Maryland coastal bays summer 2000 surveys was aggregated to the lower level of taxonomic detail so that it would be comparable with the rest of the benthic data for the Northeast Coast.

benthic communities were sampled at stations with an average depth of 57 feet, 36 feet deeper than the average depth of stations sampled in the Mid-Atlantic estuarine waters south of Cape Cod. A calibrated benthic index for the Acadian Province is not currently available. For this report, the Shannon-Weiner H' diversity index was used to characterize benthic communities in the Acadian Province. Areas of low diversity, (Shannon-Weiner H' < 0.63) were classified as poor. This cutoff point was selected to include 75% of the sites in the Acadian Province, where one or more ERMs for either metals or organics were exceeded. Based on this criterion, 9% of the coastal waters of the Acadian Province are considered poor. Some of these areas may have low diversity due to natural causes, including areas with high exposure to wave action and coarse sediment grain size, as well as mesohaline environments (<20 ppt salinity), where lower diversity is associated with salinity stress. A benthic index that is specifically calibrated for use in the coastal waters north of Cape Cod and that makes adjustments for such habitat variables is currently being developed.

The performance of the benthic index was checked against other indicators of coastal condition (except for those stations located in Chesapeake Bay). Water quality and benthic condition were sampled from the same location for all stations. For these sites, the water quality index was good, and the benthic index was good 85% of the time. Also, when the benthic index was good, DIN was good 74% of the time, DIP was good 69% of the time, and good water clarity co-occurred 71% of the time. Dissolved oxygen showed a very strong association with benthic index: when dissolved oxygen in bottom waters fell below 2.0 mg/L, indicating poor condition, the benthic index also indicated poor condition 82% of the time. There was no statistically significant co-occurrence between chlorophyll *a* and benthic index. When the sediment condition index was poor, benthic index was poor 57% of the time. A poor rating for sediment TOC was accompanied by a poor benthic index 65% of the time, and a poor sediment contamination rating was accompanied by a poor benthic index 67% of the time. Sediment toxicity was found to vary independently of benthic index. Figure 3-16 emphasizes the high degree of co-occurrence between poor benthic condition, poor water quality, and poor sediment quality.

Additional refinements to the benthic indices may provide better discrimination between good and poor

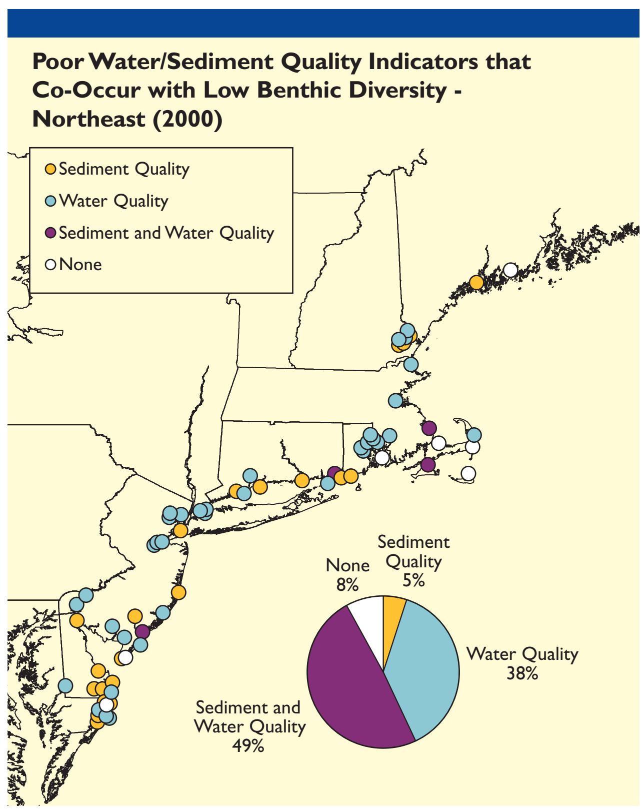


Figure 3-16. Indicators of poor water and sediment quality that co-occur with poor benthic condition in Northeast Coast estuaries (Chesapeake Bay system not included) (U.S. EPA/NCA).

conditions in specific coastal systems. Dauer et al. (2002) provides a summary of recent efforts in using benthic indices to discriminate between different sources of anthropogenic stress in Chesapeake Bay. Although benthic indices can provide important insights about the spatial extent of affected benthos, additional diagnostic work is often needed to attribute observed impacts to underlying causes.

Coastal Habitat Index

Wetlands are threatened by many human activities, including loss and destruction due to land development, eutrophication, the introduction of toxic chemicals, and the spread of non-native species. Ecologists estimate that more than one-half of the Northeast's coastal wetlands have been lost since pre-colonial times. Although modern legislation has greatly slowed the destruction, the Northeast Coast lost 650 acres between 1990 and 2000. This amounts to a loss of 0.14% over 10 years. Combining this average with the mean long-term decadal wetland loss rate from 1780 to 1990 and multiplying by 100 results in a coastal habitat index score of 1.00. This means the coastal habitat index for the Northeast Coast is rated fair to good. For more information about wetlands and threats to the region, refer to EPA's wetlands Web site, http://www.epa.gov/owow/wetlands.

Great Sippewissett Marsh, West Falmouth, Massachusetts (Edgar Kleindinst, NMFS, Woods Hole Laboratory).

Fish Tissue Contaminants Index

Estuarine condition in Northeast Coast estuaries is rated poor for concentrations of contaminants in fish tissues. Figure 3-17 shows that 31% of all sites sampled where fish were caught (48 of 156 sites) exceeded risk-based criteria guidelines used in this assessment. Whole-fish contaminant concentrations may be higher or lower than concentrations associated with fillets only. Only those contaminants that have an affinity for muscle tissue, e.g., mercury, are likely to have significantly higher concentrations in fillets than in whole fish. Concentrations for many other contaminants will be lower in fillets than in whole fish. In Northeast Coast estuaries, elevated contaminant concentrations were observed in various catfish, white perch, weakfish, lobster, flounders, scup, Atlantic tomcod, and blue crab and most often included total PCBs, total PAHs, DDT, and mercury.

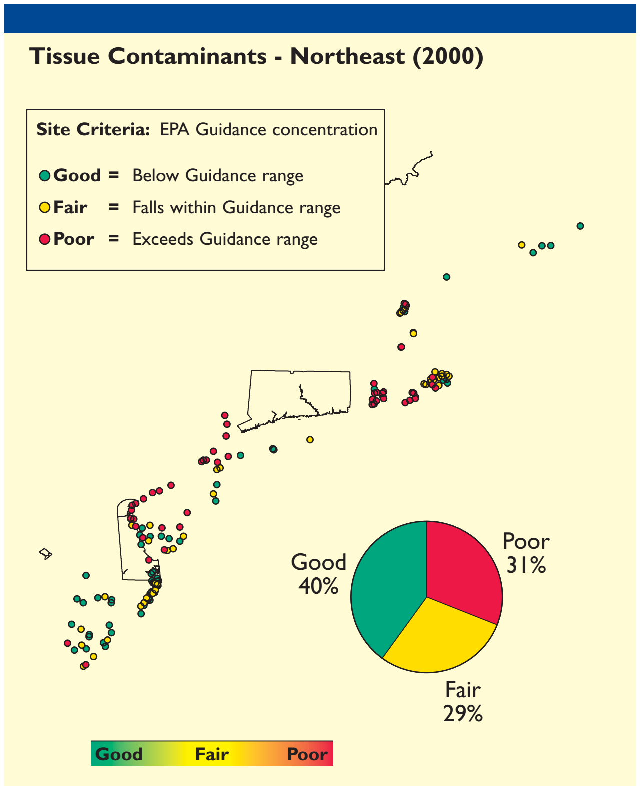
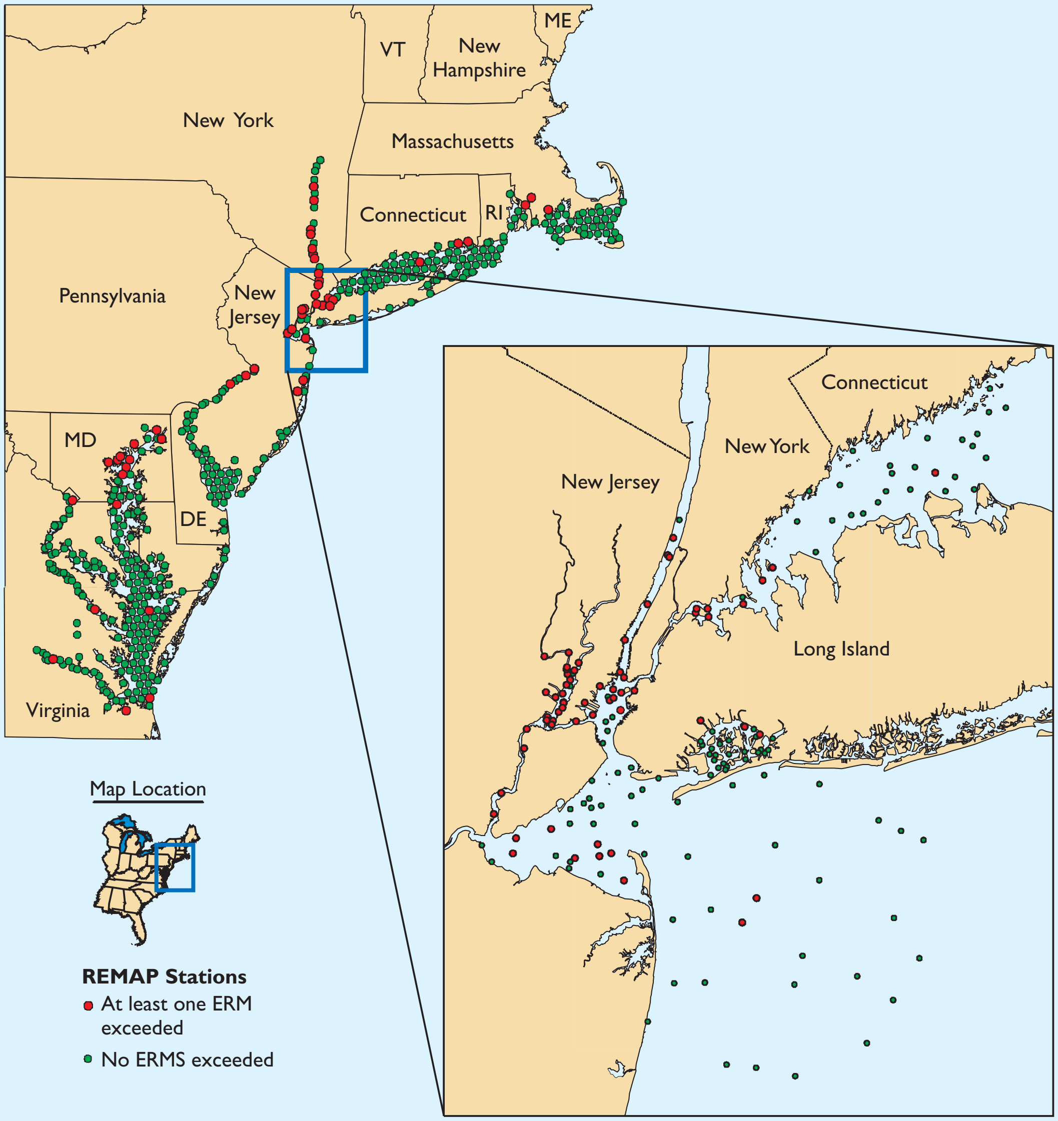


Figure 3-17. Fish tissue contaminants data for Northeast Coast estuaries (U.S. EPA/NCA).

A Case Study of Contamination Assessment in New York Harbor

One of the values of the EMAP Estuaries Program is its ability to provide broad insight about the quality of coastal waters to local managers, potentially spawning smaller, localized studies to investigate coastal conditions. For New York Harbor, results from the EMAP sampling led to a more intense Regional EMAP (REMAP) sampling, with results from these regional studies triggering a more focused sampling using the Contamination Assessment and Reduction Program (CARP). CARP is designed to identify sources of contamination in coastal waters.

EMAP 1990–1993 ERM exceedances in the Virginian Province.



1993–1994 REMAP stations in New York Harbor exceeding ERMs.

Data from EMAP–Virginia Province 1990–1993.

To managers in the New York and New Jersey areas, it was evident that sediment contamination in the New York Harbor area was a substantial problem. When examining EMAP data using ERM exceedances as one indicator of sediment contamination, New York stands out along the East Coast in its concentration of "hits." As a result of this broad-scale monitoring, the New York Harbor Estuary Program (HEP) and EPA Region 2 cooperatively developed a REMAP sampling effort, applying the probabilistic sampling approach more intensively at the local harbor scale. This monitoring plan was designed to assess contamination in the harbor, including sediment degradation and its relationship to contamination or physical properties of the sediment. The plan also examined whether this degradation is localized or widespread in New York Harbor and its sub-basins. The REMAP results showed that half of the Harbor exceeded at least one ERM criterion for contamination (Adams et al., 1998).

Using this REMAP information, the HEP coordinated CARP sampling to identify sources of contaminants and to focus on areas previously identified as contaminated with management implications of dredging activities. The goal of the HEP is to track sources of contaminants from the land, water, and air, utilizing existing state and national programs (Trackdown and Cleanup, Combined Sewer Overflow/Storm Water Abatement, Waste Site Inventory, Superfund, and the Clean Air Act) to identify possible sources, such as sewer and stormwater overflows, industrial discharges, tributary inputs, landfill leachate, accidental spills, and atmospheric deposition. Such data can be used to generate simple and complex models to identify contaminant sources, examine outcomes of clean-up efforts, support a long-term dredging monitoring plan, and make a complete assessment of the dredged material.

Large Marine Ecosystem Fisheries

The U.S. Northeast Shelf is one of the world's most productive LMEs. The most visible natural resource capital of the Northeast Shelf LME is its rich biodiversity of fish, plankton, crustacean, mollusk, bird, and mammal species. The coastal states from Maine to North Carolina currently receive $1 billion of economic benefits annually from the fisheries of the ecosystem. Management efforts are under way to rebuild the depleted condition of cod, haddock, flounder, and other fish stocks to recover the economic potential of these species.

The coastal zone draining into the Northeast Shelf LME has an area of approximately 193,050 square miles. Preliminary estimates suggest that about 7 billion gallons per day of wastewater flow into the system from municipal and industrial treatment facilities. The nitrate and phosphate loadings in several estuaries and embayments have exceeded the present "natural" capacity of the ecosystem to adequately recycle the nutrients, resulting in significant overproduction of phytoplankton and contributing to the increasing frequency and extent of HABs in near-coastal waters. Controlling the amount of nutrient loadings and adequately treating wastewater will reduce the threat of coastal eutrophication.

With appropriate management practices, the ecosystem should provide the necessary capital in natural productivity for full recovery of depleted fish stocks. Previously, severe declines in mackerel and herring populations due to overexploitation were reversed by limiting the fishery for these species through licensing and other restrictions on foreign fishing.

Fishermen maintaining gear on the dock, Gloucester, Massachusetts (Nance S. Trueworthy).

Demersal Fisheries

Northeast Shelf LME demersal (groundfish) fisheries include about 35 species and stocks in waters off New England and the Mid-Atlantic states. In the New England subsystem, the groundfish complex is dominated by members of the cod family (e.g., cod, haddock, hakes, and pollock), flounders, goosefish, dogfish sharks, and skates. In the Mid-Atlantic subsystem, groundfish fisheries include mainly summer flounder, scup, goosefish, and black sea bass.

Groundfish resources of the Northeast Shelf LME occur in mixed-species aggregations, resulting in significant bycatch interactions among fisheries directed to particular target species or species groups. Management is complex because of these interactions. This complexity is reflected, for example, in the use of different mesh, gear, minimum landing sizes, and seasonal closure regulations set by the various management bodies in the region (e.g., New England Fishery Management Council [NEFMC], Mid-Atlantic Fishery Management Council [MAFMC], Atlantic States Marine Fisheries Commission [ASMFC], individual states, and the Canadian government). New England groundfish (14 species) are managed primarily under the *Northeast Multispecies Fishery Management Plan,* as well as peripherally under provisions of the ASMFC's *Northern Shrimp Fishery Management Plan*. Summer flounder, scup, and black sea bass are managed under a joint ASMFC–MAFMC fishery management plan (FMP), and weakfish are managed under an ASMFC FMP. Demersal fisheries in New England were traditionally managed primarily by indirect methods, such as regulating fishing gear mesh sizes, imposing minimum fish lengths, and closing some areas. The principal regulatory measures currently in place for the major New England groundfish stocks are limits on allowable days at sea for fishing, along with closure of certain areas, trip limits (for cod and haddock), and targets for total allowable catch that correspond to target fishing mortality rates. The *Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan* includes provisions for catch quotas aimed at restoring these stocks.

Extensive historical data for the Northeast Shelf LME demersal fisheries have been derived from both fishery-dependent (i.e., catch and effort monitoring) and fishery-independent (e.g., NOAA research vessel) sampling programs since 1963. The boundaries of the Northeast Shelf LME are depicted in Figure 3-18. Since 1989, a sea-sampling program has been conducted aboard commercial fishing vessels to document vessel discard rates and to collect high-quality, high-resolution data on their catch. Despite the past management record, some of the Northeast Shelf LME demersal stocks (e.g., cod, yellowtail flounder, haddock, American plaice, and summer flounder) are among the best understood and assessed fishery resources in the country.

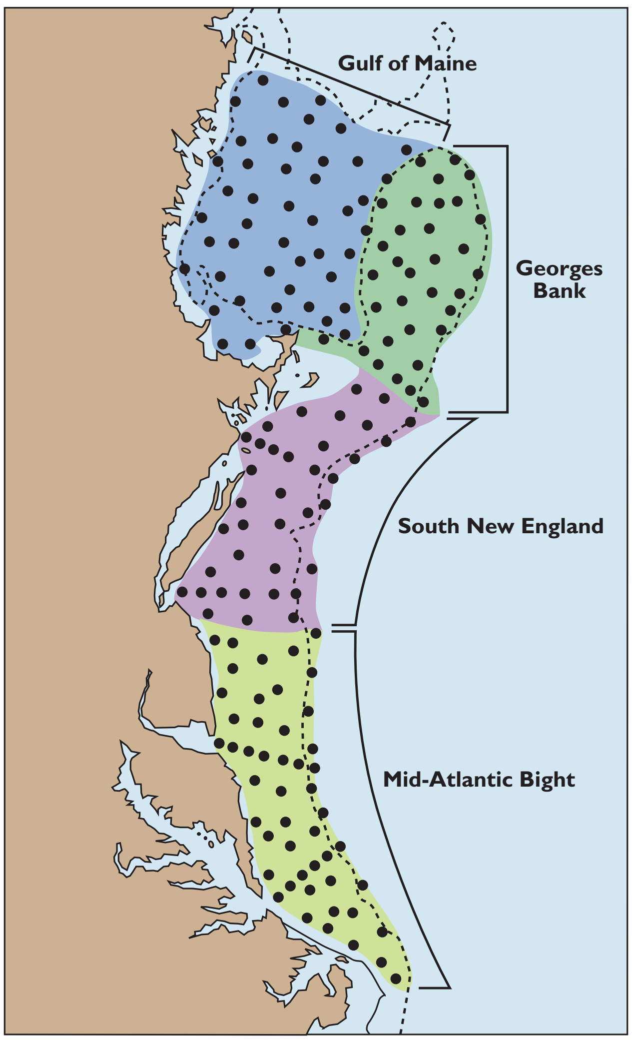


Figure 3-18. Northeast Shelf LME subareas and sampling locations (Sherman et al., 2003).

Principal Groundfish and Flounders

The principal groundfish and flounders group includes important species in the cod family (e.g., Atlantic cod, haddock, silver hake, red hake, and pollock), flounders (e.g., yellowtail, summer, winter, witch, windowpane, and American plaice), and redfish. Recent annual landings of these 12 species (representing 19 stocks) have averaged 81,000 mt (69% U.S. commercial, 21% Canadian, and 10% U.S. recreational landings), compared with a combined long-term potential yield of 247,000 mt (Figure 3-19). Total revenue to fishers from the principal U.S. groundfish and flounder commercial landings in 2000 was $121 million, compared with $109 million in 1997. The Northeast groundfish complex supports important recreational fisheries for species, including summer flounder, Atlantic cod, winter flounder, and pollock.

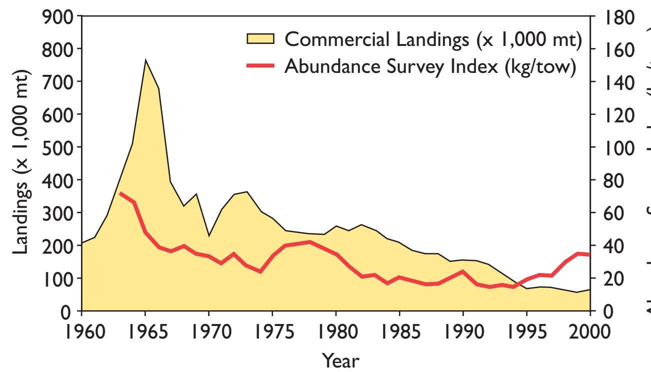


Figure 3-19. Landings in metric tons (mt) and abundance index of principal groundfish and flounders, 1960–2000 (NMFS, 2003).

The abundance index for this group of species declined by almost 70% between 1963 and 1974, reflecting substantial increases in exploitation associated with the advent of distant-water fleets. Many stocks in this group declined sharply, notably Georges Bank haddock, most silver and red hake stocks, and most flatfish stocks. By 1974, indices of abundance for many of these species had dropped to the lowest-ever recorded levels.

Groundfish partially recovered during the mid-to-late 1970s because of reduced fishing efforts associated with increasingly restrictive management. Cod and haddock abundance increased markedly, stock biomass of pollock increased more or less continually, and recruitment and abundance also increased for several flatfish stocks.

The abundance index peaked in 1978, but subsequently declined, and fell to new lows in 1987 and 1988. The abundance index for the principal groundfish and flounders fell to a 30-year low in 1992, but has subsequently more than doubled since that year (Figure 3-19). The most recent changes in the aggregate index are due primarily to substantial increases (since 1996) in the biomass index for redfish in the Gulf of Maine subarea (Northeast Fisheries Science Center, 2001a), but also reflect increased biomasses of haddock and yellowtail flounder in the Georges Bank subarea (Northeast Fisheries Science Center, 2001b).

Landings of most groundfish species declined substantially during the mid-1990s. For many stocks, landings continue to remain relatively low because of generally poor recruitment and despite continued restrictions on days at sea, low trip limits, and additional area closures in the Gulf of Maine. However, for some stocks, including Georges Bank yellowtail flounder and haddock, strong year-classes appearing in 1997 and 1998, respectively, combined with sharp reductions in fishing mortality, led to improved stock conditions (Northeast Fisheries Science Center, 2001b) and resulted in increased landings during 1999 and 2000.

Management Concerns

During most of the 1980s and early 1990s, New England Shelf ecosystem groundfish harvests were regulated by indirect controls on fishing mortality, such as mesh and fish size restrictions, and some area closures. Since 1994, these controls have been more stringent and focused. Amendment 5 to the NEFMC's *Multispecies Fishery Management Plan*, implemented in March 1994, marked the beginning of an effort-reduction program to address the requirement to eliminate the overfished conditions of cod, haddock, and yellowtail flounder. The regulatory package included a moratorium on new vessel entrants, a schedule to reduce the number of days at sea for trawl and gill net vessels, increases in regulated mesh size, and expanded closed areas to protect haddock. Since December 1994, three large areas have also been closed to protect the regulated groundfish stocks; these include Closed Areas I and II on Georges Bank and the Nantucket Lightship Closed Area.

A groundfish vessel buyout program was initiated in 1995, first as a pilot project and later as a comprehensive fishing capacity-reduction project. The program was designed to provide economic assistance to fishermen adversely affected by the collapse of the groundfish fishery and who voluntarily chose to remove their vessels permanently from the fishery. This reduction in vessels helps fish stocks recover to a sustainable level by reducing the excess fishing capacity in the Northeast Shelf LME. The vessel buyout program, which concluded in 1998, removed 79 fishing vessels at a cost of nearly $25 million and resulted in an approximate 20% reduction in fishing effort in the Northeast Shelf LME groundfish fishery.

This flounder is one of several flatfish species found on the Stellwagen Bank and in the basin. Development of juveniles occurs primarily within sheltered bays and estuarine areas (Dann Blackwood and Page Valentine, USGS).

Pelagic Fisheries

The Northeast Shelf LME pelagic fisheries are dominated by four species: Atlantic mackerel, Atlantic herring, bluefish, and butterfish. Mackerel, herring, and butterfish are considered to be underutilized, and bluefish are considered to be overutilized. The abundance of mackerel, herring, and butterfish is presently above average, whereas that of bluefish is below average.

The long-term population trends for mackerel and herring, as measured by research vessel survey data, have fluctuated considerably during the last 25 years (Figure 3-20). The combined abundance index for these two species reached minimal levels in the mid- to late 1970s, reflecting pronounced declines for both species and a collapse of the Georges Bank herring stock, but the index subsequently increased steadily and peaked in 1999.

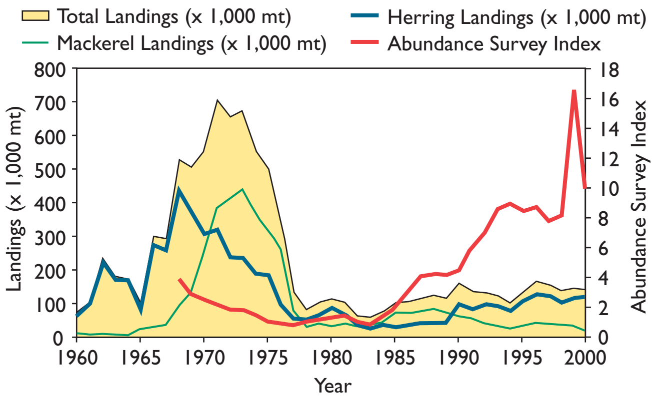
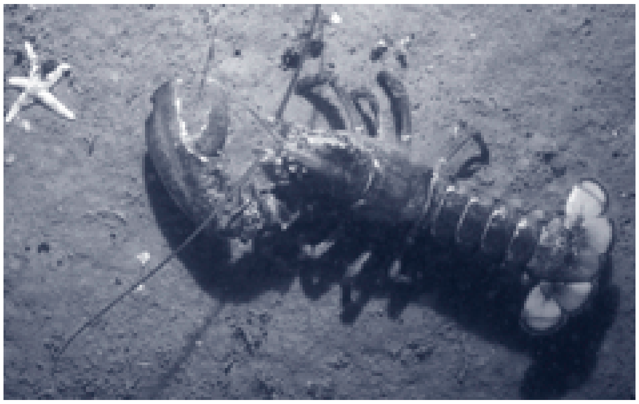


Figure 3-20. Landings in metric tons (mt) and abundance index of principal pelagic fish stocks, 1960–2000 (NMFS, 2003).

Although historical catch data (except perhaps for bluefish) are generally adequate for assessment purposes, stock assessments for the Northeast Shelf LME pelagic resources are relatively imprecise, owing to the highly variable trawl survey indices of abundance used for calibrating cohort analysis models, the short life span of some stocks (butterfish), and the current low exploitation rates of some species (mackerel and herring). The development of more precise assessments will require the use of hydroacoustic and mid-water trawl surveys to estimate herring and mackerel abundance, as well as alternative types of sampling surveys to estimate bluefish abundance. In 1997, autumn hydroacoustic surveys were implemented to improve stock assessments for Atlantic herring by indexing spawning concentrations. Research is under way to estimate the size of herring spawning groups directly from these surveys and to combine these estimates with data from traditional catch-at-age methods.



The American lobster (*Homarus americanus*) finds homes in rock piles or digs holes in muddy places. Its claws, used for catching and crushing prey, can be regenerated if lost, as in the case here. Lobsters come in a variety of colors, including mottled reddish brown, white, and blue (Dann Blackwood and Page Valentine, USGS, Woods Hole, Massachusetts).

Northeast Shelf Ecosystem Invertebrate Fisheries

Offshore fisheries for crustacean and molluscan invertebrates are among the most valuable fisheries of the Northeast Shelf LME. In 2000, U.S. commercial landings of American lobster (38,300 mt) and sea scallops (14,500 mt of shucked meats) ranked first and second in overall ex-vessel value ($304 million and $165 million, respectively). Landings of surf clams, ocean quahogs, squids, and northern shrimp contributed another roughly $100 million in revenue. Revenues from these invertebrate fisheries exceeded those for all Northeast Shelf LME finfish fisheries combined.

American Lobster

A recent assessment of American lobster stocks (ASMFC, 2000) indicated that fishing mortality rates for lobster in the Gulf of Maine were double the overfishing level. For the inshore resource distributed from southern Cape Cod through Long Island Sound and for the offshore stock on Georges Bank, fishing mortality substantially exceeded the overfishing level. Throughout its range, the lobster fishery has become increasingly dependent on newly recruited animals, and commercial catch rates have markedly declined in heavily fished nearshore areas. In some locations, more than 90% of the lobsters landed are new recruits to the fishery, almost all of which are juveniles (i.e., not yet sexually mature). Fishing mortality rates for both inshore and offshore stocks presently far exceed the levels needed to produce maximum yields. Lobster landings during 1998–2000 averaged 38,100 mt, with a record-high catch of 39,700 mt in 1999 (Figure 3-21). Despite overfishing, lobster abundance has remained high due to favorable environmental conditions for lobster reproduction and recruitment.

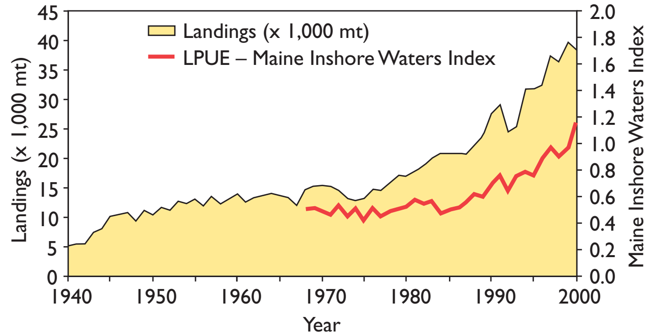


Figure 3-21. Landings of American lobster in the northeastern United States, 1940–2000, in metric tons (mt). The index shows the average number of legal-sized lobsters caught per trap averaged over a 24-hour period in Maine inshore waters (NMFS, 2003). (LPUE = landings per unit effort)

Sea Scallops

Sea scallops are harvested in the United States in the Northeast Shelf LME from Cape Hatteras, North Carolina, to the U.S./Canadian border on Georges Bank and in the Gulf of Maine. Dredges are the principal harvesting gear, although otter trawls take a small proportion of the landings (Serchuk and Murawski, 1997).

Management of the sea scallop fishery changed markedly in 1994, when—to address overfishing—management measures affecting the number of days at sea, vessel crew size, and dredge-ring size were implemented. Since December 1994, the harvesting of sea scallops in two areas on Georges Bank and one area on Nantucket Shoals (closed to protect depressed groundfish stocks) has been prohibited, except under highly controlled, limited area-access provisions. In April 1998, two areas in the Mid-Atlantic subarea were also closed (for 3 years) to scallop fishing to protect large numbers of juvenile scallops.

A recent stock assessment (Northeast Fisheries Science Center, 2001b) indicated that sea scallop biomass in the closed areas increased dramatically between 1994 and 2000. Smaller but substantial increases also occurred in areas open to fishing as a result of reduced fishing effort and good reproductive success. Increases in stock biomass generated large increases in U.S. scallop landings in both 1999 and 2000 (Figure 3-22).

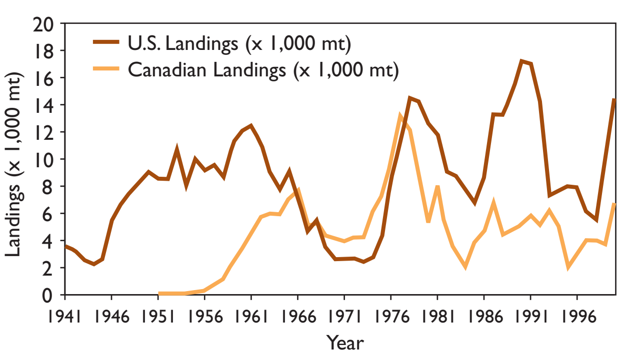


Figure 3-22. Landings of Atlantic sea scallop in the United States and Canada, 1940–2000, by metric tons (mt).

Assessment and Advisory Data

Clean Water Act Section 305(b) Assessments

The states on the Northeast Coast assessed 10,582 (85%) of their 12,451 estuarine square miles for their 2000 305(b) reports. They used state-specific criteria, which may differ from those used in the NCA analysis, and found that 49% of the assessed estuarine waters fully support their designated uses, 8% are threatened for one or more uses, and the remaining 43% are impaired by some form of pollution or habitat degradation (Figure 3-23). Individual use support for estuaries is shown in Figure 3-24.

In 2000, Northeast Coast states assessed 404 (5%) of their 7,716 shoreline miles. Ninety-two percent of the assessed shoreline waters fully support their designated

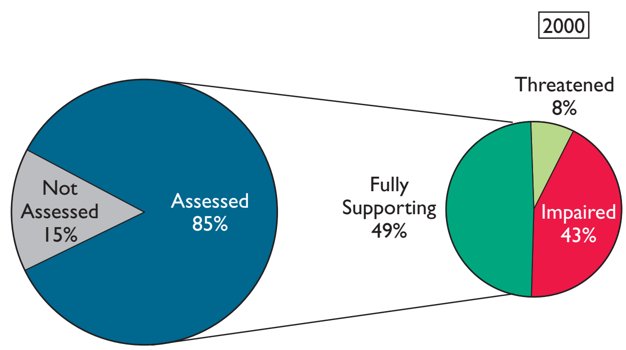


Figure 3-23. Water quality in assessed Northeast Coast estuaries (U.S. EPA, 2002).

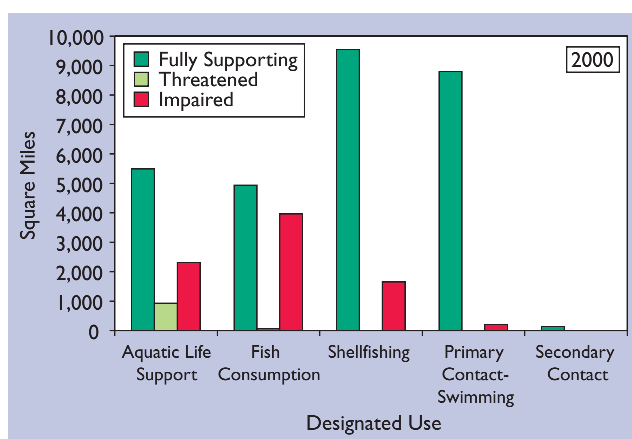


Figure 3-24. Individual use support in assessed Northeast Coast estuaries (U.S. EPA, 2002).

uses, and no uses are reported as threatened; however, 8% are impaired by some form of pollution or habitat degradation (Figure 3-25). Individual use support for Northeast Coast shoreline waters is shown in Figure 3-26 and listed in Table 3-2.

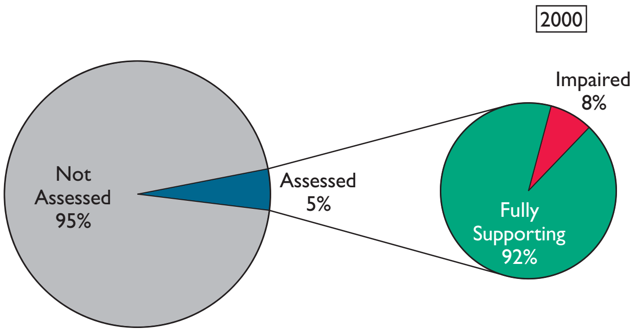


Figure 3-25. Water quality in assessed shoreline waters of the Northeast Coast (U.S. EPA, 2002).

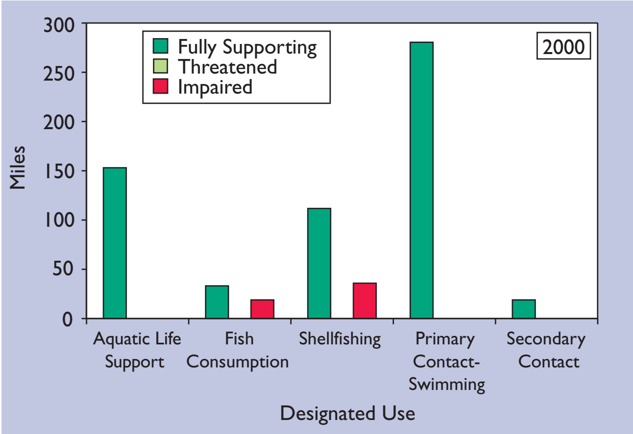


Figure 3-26. Individual use support for assessed shoreline waters of the Northeast Coast (U.S. EPA, 2002).

Table 3-2. Individual Use Support for Assessed Shoreline Waters Reported by the Northeast Coast States under Section 305(b) of the Clean Water Act (U.S. EPA, 2002).

Individual Uses	Assessed Estuaries Impaired (mi^2) and Percentage of Total Area Assessed for the Individual Use	Assessed Shoreline Impaired (mi) and Percentage of Total Area Assessed for the Individual Use
Aquatic life support	2,335 (27%)	0
Fish consumption	3,950 (38%)	18 (36%)
Shellfishing	1,665 (15%)	35 (24%)
Primary contact – swimming	221 (3%)	0
Secondary contact	10 (7%)	0

Replanting marsh grass in an effort to protect and rebuild this beach near Annapolis, Maryland (Mary Hollinger, NODC biologist, NOAA).

Fish Consumption Advisories

In 2002, 7 of the 10 Northeast Coast states (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, and Rhode Island) had statewide consumption advisories for fish in coastal waters, placing nearly all of their coastal and estuarine areas under advisory. Due in large part to these statewide advisories, an estimated 81% of the coastal miles of the Northeast Coast and 56% of the estuarine area were under fish consumption advisories. A total of 33 different advisories were active in 2002 for the estuarine and coastal waters of the Northeast Coast (Figure 3-27).

Advisories in the Northeast Coast were in effect for 10 different pollutants (Figure 3-28). Most of the listings (94%) were, at least in part, caused by PCBs. Boston Harbor was listed for multiple pollutants.

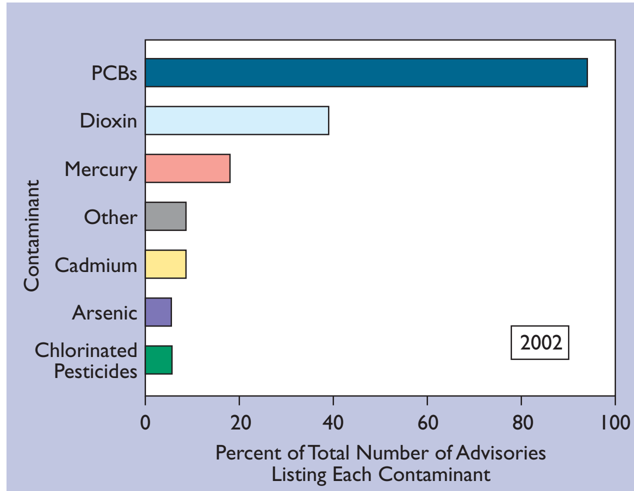


Figure 3-28. Pollutants responsible for fish consumption advisories in northeastern coastal waters. An advisory can be issued for more than one contaminant, so percentages may not add up to 100 (U.S. EPA, 2003c).

These species were under advisory in 2002 for at least some part of the Northeast Coast:

American eel	Scup
Bluefish	Striped bass
Brown bullhead	Tilefish
Flounder	White catfish
Lobster	Bivalves
Rainbow smelt	Blue crab (hepatopancreas)
Smallmouth bass	Common carp
Tautog	Largemouth bass
Walleye	Northern hogsucker
Atlantic needlefish	Shark
Blue crab	Swordfish
Channel catfish	Tuna
King mackerel	White perch
Lobster (tomalley)	Source: U.S. EPA, 2003c

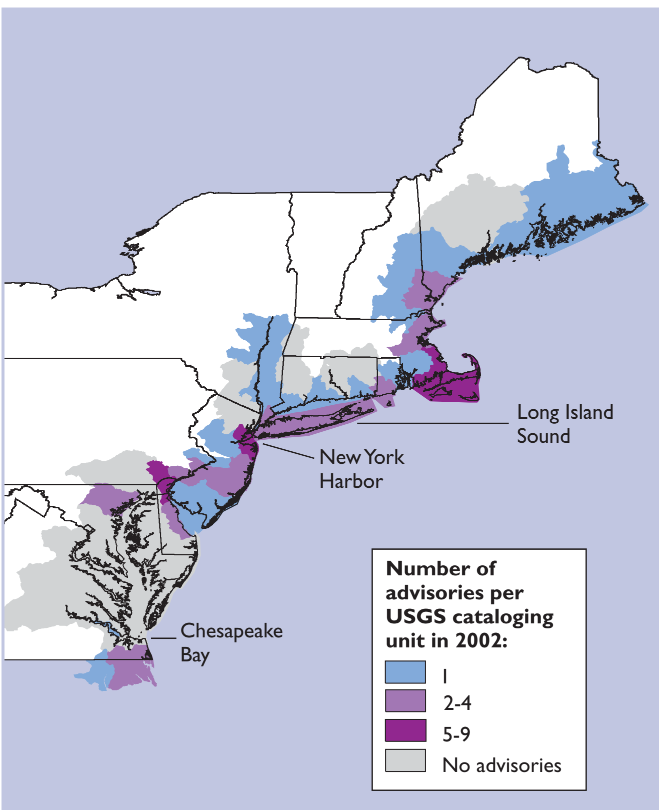


Figure 3-27. The number of fish consumption advisories for the Northeast Coast active in 2002 (U.S. EPA, 2003c).

Filleting the day's catch. Patuxent River, Maryland (Mary Hollinger, NESDIS/NODC biologist, NOAA).

Beach Advisories and Closures

Of the 826 coastal beaches in the Northeast Coast that reported information to EPA, only 18% (151 beaches) were closed or under advisory for any period of time in 2002. The states with the highest percentage of beaches with advisories/closures were Maryland and New York, where 33% of 12 beaches and 31% of 199 beaches, respectively, indicated that they were closed at least once in 2002. Table 3-3 presents the number of beaches and advisories/closures for each state. Figure 3-29 shows the percentage of beaches in each county that had at least one advisory or closure in 2002. Only two states in the region (New Hampshire and Virginia) did not have any coastal beach closings in 2002. All of the beaches in the Northeast Coast that reported information have monitoring programs.

The primary reasons why beach advisories and closures were implemented at coastal beaches in the Northeast were elevated bacteria levels or preemptive closures associated with rainfall events or sewage-related problems. Most beaches had multiple sources of water-borne bacteria that resulted in advisories or closures (Figure 3-30). Stormwater runoff and wildlife were most frequently identified as sources, and unknown sources accounted for 28% of the response (Figure 3-31).

Table 3-3. Number of Beaches and Advisories/Closures in 2002 for Northeast Coast States (U.S. EPA, 2003a)

State	No. of Beaches	No. of Advisories/ Closures	Percentage of Beaches Affected by Advisories/ Closures
Maine	7	1	14.3%
New Hampshire	13	0	0.0%
Massachusetts	199	45	22.6%
Rhode Island	74	8	10.8%
Connecticut	70	18	25.7%
New York	199	62	31.2%
New Jersey	228	10	4.4%
Delaware	15	3	20.0%
Maryland	12	4	33.3%
Virginia	9	0	0.0%
TOTALS	826	151	18.3%

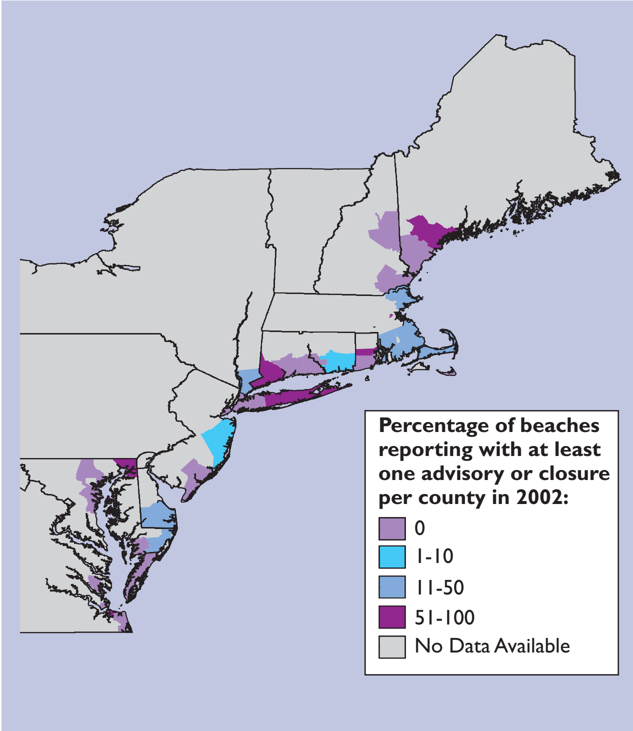


Figure 3-29. Percentage of beaches with advisory or closures by county for the Northeast Coast (U.S. EPA, 2003a).

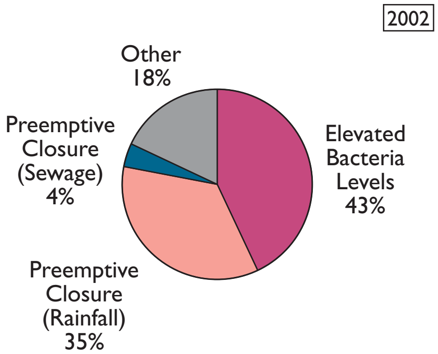


Figure 3-30. Reasons for beach advisories or closures for the Northeast Coast (U.S. EPA, 2003a).

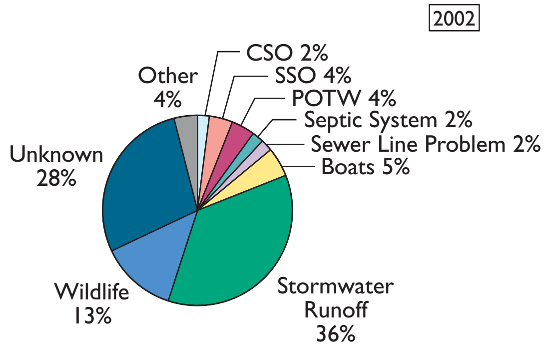


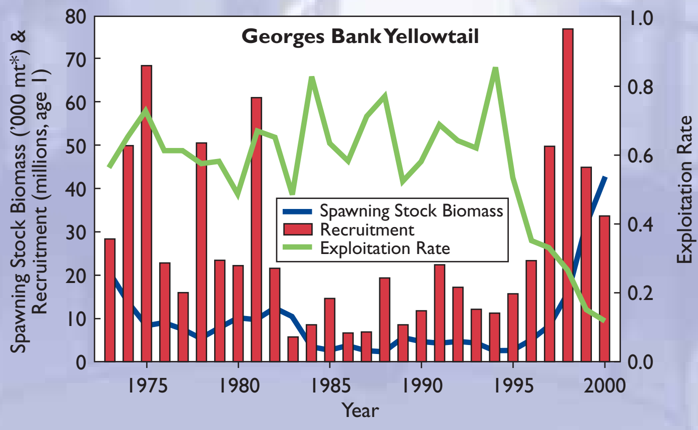
Figure 3-31. Sources of beach contamination for the Northeast Coast (U.S. EPA, 2003a).

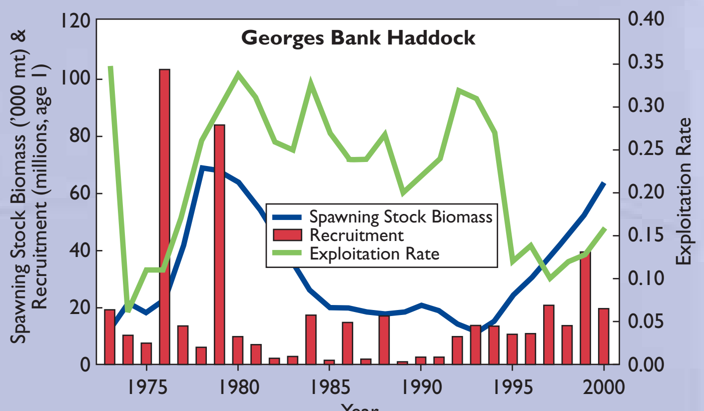
highlight

Recovery from Biomass Depletion in Large Marine Ecosystems

Multi-year time series measurements of the plankton in two LMEs have shown that phytoplankton and zooplankton populations are in good condition, indicative of a stable and highly productive food-web base. The robust condition of plankton enhances conditions for reversing the declines in biomass of demersal fish that have occurred over the last several decades. Since 1994, mandated reductions in fishing effort led to increases in the spawning stock biomass (SSB) levels of haddock, yellowtail flounder, and other species in the Northeast Shelf ecosystem.

Following the cessation of foreign fishing on herring and mackerel stocks in the late 1970s and a decade of very low fishing mortality, both species began to recover to high stock sizes in the 1990s. Bottom trawl survey indices for both species increased dramatically, showing more than a 10-fold increase in abundance (1977–1981 vs. 1995–1999 averages) by the late 1990s. Stock biomass of herring increased to more than 2.5 million mt by 1997. The total stock biomass of mackerel has also continued to increase since the closure of the foreign fishery in the late 1970s. Although absolute estimates of biomass for the late 1990s are not available, recent analyses place the stock at or near a historic high in total biomass and SSB. Additionally, recent evidence indicates that both haddock and yellowtail flounder stocks are responding favorably to catch reductions, with substantial growth reported in SSB size since 1994 for haddock and flounder. In 1998, a very strong year-class of yellowtail flounder was produced, and in 1999, a strong year-class of haddock was produced, as shown in the figures to the right.





*mt - metric tons

Source: Sherman et al., 2003.

At the base of the food web, primary productivity provides an input of carbon that supports important marine commercial fisheries. Zooplankton production and biomass provide the prey-resource for larval stages of fish and the principal food source for herring and mackerel in waters of the Northeast Shelf ecosystem. During the past 20 years, the long-term median value for the zooplankton biomass of the Northeast Shelf ecosystem has been about 29 cubic centimeters of zooplankton per 100 m^3 of water, produced from a stable mean-annual primary productivity of 350 grams of carbon per square meter per year (gCm^2yr). During the last two decades, the zooplanktivorous herring and mackerel stocks underwent unprecedented levels of growth, approaching an historic high combined biomass. This growth took place during the same period that the fishery management councils for the New England and Mid-Atlantic areas sharply curtailed fishing effort on haddock and yellowtail flounder stocks. Given the observed robust levels of primary productivity and zooplankton biomass, it appears that the carrying capacity of zooplankton is sufficient to sustain the strong year-classes reported for yellowtail flounder (1998) and haddock (1999).

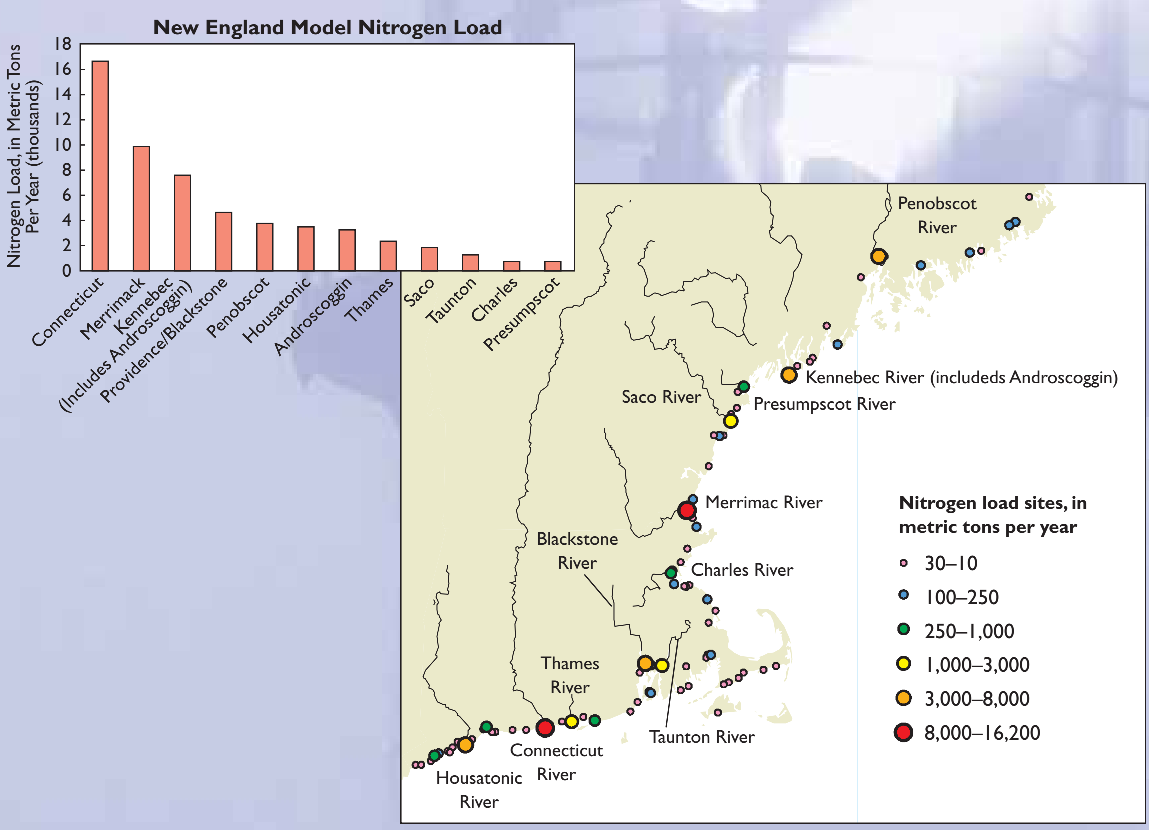
An undulating oceanographic recorder, towed behind a ship, is used to collect ecological parameters needed to assess the state of the marine ecosystem (Jerome Prezioso, NOAA NMFS).

The zooplankton component of the Northeast Shelf ecosystem is in a robust condition, with biomass levels at or above the levels of the long-term median values of the past two decades. This supplies a suitable prey base for supporting a large biomass of pelagic fish (herring and mackerel), and provides sufficient zooplankton prey to support strong year-classes of recovering haddock and yellowtail flounder stocks. The Northeast Shelf ecosystem is in relatively stable oceanographic condition. No evidence has been found in the fish, zooplankton, temperature, or chlorophyll components that indicates any large-scale oceanographic regime shifts of the magnitude reported for the North Pacific or northeast Atlantic Ocean areas.

For more information, contact Ken Sherman at kenneth.sherman@noaa.gov.

Predicted Nitrogen and Phosphorus Loads to the New England Coast using SPARROW Model

In the 1980s and 1990s, the USGS developed SPARROW models to assist in performing national and regional water quality assessments (Smith et al., 1993 and 1997). SPARROW, which refers to Spatially Referenced Regressions on Watershed Attributes, uses regression equations to relate measures of water quality condition to pollution sources and watershed characteristics. These relations are then used to provide estimates of water quality fluxes at unmonitored waters. In 2004, New England SPARROW models were completed by the USGS, in cooperation with EPA and the New England Interstate Water Pollution Control Commission (NEIWPCC). The models provide nutrient (total nitrogen [TN] and total phosphorus [TP] flux estimates for nearly 42,000 stream reaches throughout the region (Moore et. al., 2004). The models were calibrated using nutrient measurements at nearly 70 sites where the USGS and other agencies measure water quality conditions.



Nitrogen loadings from New England watersheds to coastal waters as predicted by the New England SPARROW model (Moore et al., 2004).

The New England SPARROW models have r^2 values of 0.95 for the TN model and 0.94 for the TP model. Significant predictors of TN include atmospheric deposition, developed (urban and suburban) land area, agricultural land area, and discharges from municipal wastewater-treatment facilities. Significant predictors of TP include agricultural land area, developed land area, forested land area, and discharges from municipal wastewater-treatment and pulp and paper facilities.

Development of a New England SPARROW model is being used to enhance the ability of EPA Region 1 to meet requirements under the Clean Water Act, including development of TMDL studies for waters impaired by pollutants and development of nutrient criteria. The New England SPARROW model will provide the following information:

- Estimated mean annual loadings of TN and TP in all 42,000 New England stream segments for the mid-1990s time period
- Estimated TN and TP loadings contributed by pollutant sources in each stream segment
- Estimated TN and TP loadings from individual stream segments to downstream stream TN and TP loadings within watersheds and to coastal waters
- Information on the impact of nutrient-sources (e.g., wastewater treatment facilities; forested, urban, suburban, and agricultural lands), and watershed characteristics (e.g., presence of reservoirs and lakes, and stream-flow velocities) on pollutant loads
- Estimates of TN and TP fluxes to New England coastal waters for use in assessment of coastal conditions as part of the ongoing NCA Program.

Additional information on SPARROW models nationally is available at http://water.usgs.gov/nawqa/sparrow/index.html, and the New England SPARROW Report can be obtained at http://water.usgs.gov/pubs/sir/2004/5012/.

Virginia Seaside Heritage Program

Virginia's Eastern Shore—a vast system of barrier islands, bays, and salt marshes—is a global treasure designated by the United Nations (UN) as a Man and the Biosphere Reserve. The intertidal and shallow subtidal areas, undeveloped beaches, and marshes support an incredible array of waterfowl and shorebirds. These habitats also serve as breeding, nursery, and foraging sites for finfish and shellfish, which are of tremendous economic value to commercial and recreational fishermen.

Blue-eyed bay scallop.

In the 1800s, this barrier island lagoon system was a mecca for hunting, fishing, and recreation for people from Washington, DC, to New York. Finfish and shellfish harvests provided income to thousands of Virginians. Unfortunately, seafood harvests of all types and shorebird populations declined dramatically beginning in the late 1800s due to over-harvesting, disease, the environment, and loss of habitat. Destructive hurricanes and storms also hit Virginia's seaside in the 1880s, 1890s, and early 1900s, and bird populations have declined steadily due to hunting, predation, and habitat loss. Sadly, despite strong conservation efforts over the last few decades, there has not been a great resurgence of seagrasses, oysters, scallops, finfish, and birds.

The Virginia Seaside Heritage Program (VSHP), a new public-private partnership initiated by the VCP and its partners, is an ambitious 3-year program (2002–2004) aimed at restoration, use-conflict resolution, and protection of the aquatic resources of the seaside. The VSHP will build on the momentum of recent restoration success and develop the tools necessary to support long-term restoration and management strategies for the seaside. This area holds tremendous potential to demonstrate appropriate management of economic development and habitat restoration within a rare and fragile ecosystem.

This 3-year program has four elements:

- Development of a comprehensive seaside inventory of natural resources and human use patterns that will form the basis for long-term restoration and management strategies
- Restoration of seagrass acreage, scallop beds, oyster reefs, marshes, and shorebird habitats
- Development of management tools, such as a use-suitability model, improved enforcement capabilities, and public education efforts.
- Development of sustainable ecotourism opportunities through construction or enhancement of public access sites, creation of a canoe/kayak water trail and map, and an ecotour guide certification course.

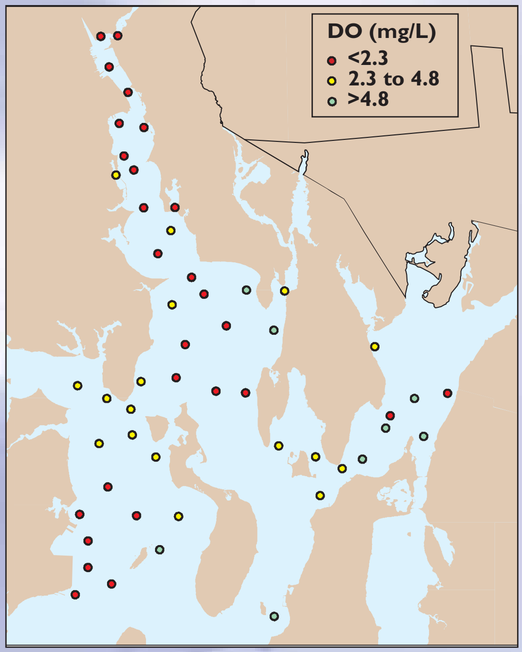
For more information about this project, please contact Laura McKay, VCP Manager, at (804) 698-4323 or lbmckay@deq.state.va.us. Please also visit the VSHP Web site at http://www.deq.state.va.us/coastal/vshpweb/homepage.html.

Use of a Hybrid Monitoring Design in Rhode Island

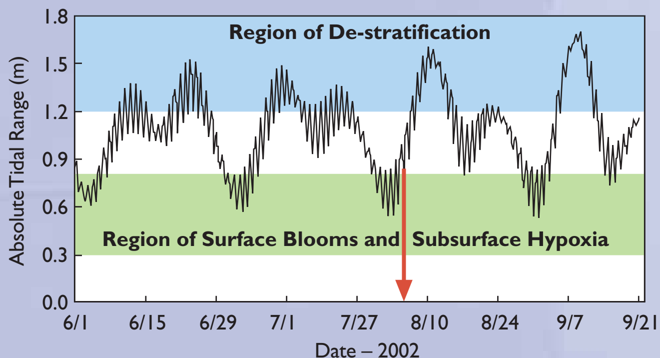
Rhode Island's monitoring program for Narragansett Bay includes random samples during the NCA index period; measurements made from moored instrumentation recording water properties every 15 minutes; towed instrumentation; and targeted sampling designed to document the spatial extent of low dissolved oxygen events that often accompany minimal tidal range in summer and early fall. The upper Narragansett Bay stratifies when the tidal range is less than 0.8 meters.

Phytoplankton often bloom in the surface layer when upper Narragansett Bay stratifies, followed by subsurface declines in dissolved oxygen (Bergando, In press). The August 6 sampling date was selected one year in advance of when a low dissolved oxygen event was considered likely, following a period of minimum tidal range.

Information from two of the moored instruments in upper Narragansett Bay indicated that, preceding the target sampling on August 6, 2002, near–bottom dissolved oxygen concentrations fell below EPA's (U.S. EPA, 2000a) chronic criterion for dissolved oxygen (4.8 mg/L) for 10 days and below the acute criterion for dissolved oxygen (2.3 mg/L) for 5 days. This low dissolved oxygen event was accompanied by fish kills in upper Narragansett Bay.



Dissolved oxygen concentrations in Upper Narragansett Bay, August 6, 2002.



Absolute tidal range – Newport, Rhode Island. (developed by Dana Kester [deceased], formerly of URI GSO)

Summary

The NCA Program is providing an important baseline of conditions that can serve as the benchmark for determining how conditions change in the 21st century. For the first time, consistently collected data sets from cooperating state programs permit statistically valid comparisons of coastal conditions across the region. The summary of NCA results in this chapter is based on observations from a single survey year of the Northeast Coast during a late-summer index period. Even without temporal replication, dramatic geographic gradients are evident because of the geological history, latitudinal variations in climate and tidal range, and human activities in this region.

Problems associated with excess nutrients from human activities are much less prevalent in the Gulf of Maine than in the waters to the south of Cape Cod. Problems related to low oxygen levels in bottom waters are more severe in the coastal waters of the Virginian Province. The NCA sampling design provides a snapshot of late-summer conditions across the Northeast Coast region. Low oxygen levels between 2 and 5 mg/L are evident in a number of areas. Oxygen concentrations that persist below 4.8 mg/L and periodic fluctuations below 2.3 mg/L (Coiro et al., 2000) can have an impact on benthic communities and lead to fish kills.

Clean sediments with low levels of chemical contamination, an absence of acute toxicity, and moderate to low levels of TOC are found in 73% of the Northeast Coast. High levels of sediment contaminants are found in 8% of the region, with the highest levels of sediment contaminants often found in depositional environments in the vicinity of cities (Figures 3-3 and 3-13). Such sediments require special care when dredging is needed to maintain navigation channels. Lower levels of sediment contamination are found over an additional 12% of the region, associated with areas of high human population density (Figure 3-3). Sediment toxicity is found only in 8% of the Northeast Coast (Figure 3-12). In many situations where low levels of sediment contamination are evident, sediments are found to be nontoxic. In situations where sediment toxicity is evident, additional Toxicity Identification Evaluation (TIE) approaches can be used to help diagnose causes of observed toxicity.

Assessment of communities of benthic organisms can be used to characterize Northeast Coast ecosystem conditions. Based on the benthic index used in this study, conditions are considered to be good along the northern Maine coast, Cape Cod Bay, most of southeastern Massachusetts, near the mouth of Narragansett Bay, eastern Long Island Sound, portions of New Jersey, and the eastern shore of Chesapeake Bay. Benthic conditions are considered to be poor in 22% of the Northeast Coast, often in the vicinity of high human population density.

For the Northeast Shelf LME, mandated management actions have resulted in some recovery of depleted haddock and yellowtail flounder spawning stocks biomass and good recruitment.